



First records of the occurrence of twelve species of Sabethini (Diptera, Culicidae) in the state of Paraná, southern Brazil

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Abstract

We report on the first records of Sabethini mosquitoes in the state of Paraná, based on specimens collected in forested environments between 2004 and 2005. In total, 12 species were identified, including 7 species of *Wyeomyia* Theobald, 1901 and 5 species of *Sabates* Robineau-Desvoidy, 1827. Among them, 6 are new records for the southern region of the country, and 6 are new records for the state of Paraná. These results indicate the occurrence of relict species of mosquitoes in Paraná, as they were collected from portions of forests that preserve original characteristics.

Key words

Diversity, geographic distribution, Sabethini, tropical forest.

Academic editor: Fabio Laurindo da Silva | Received 19 July 2018 | Accepted 6 December 2018 | Published 15 February 2019

Citation: da Silva AM, dos Santos DR, Cristóvão EC, Ferreira AC, Postai C, Westphal-Ferreira B, da Silva MAN (2019) First records of the occurrence of twelve species of Sabethini (Diptera, Culicidae) in the state of Paraná, southern Brazil. Check List 15 (1): 193–201. <https://doi.org/10.15560/15.1.193>

Introduction

Sabethini (Diptera, Culicidae) are diurnal mosquitoes found both in forested environments and next to anthropic areas. These mosquitoes occur in various regions of the world but are most abundant in tropical and subtropical climates where high amounts of rainfall favor the formation of aquatic micro-ecosystems known as phytotelmata. Sabethini females lay eggs on phytotelmata and the immature forms of this mosquito develop there (Forattini 2002).

In the Americas there are 9 genera of Sabethini in about 221 species, mostly found in tropical climates: *Isostomyia*,

Johnbelkinia, *Limatus*, *Phoniomyia*, *Runchomyia*, *Sabates*, *Shannoniana*, *Trichoprosopon* and *Wyeomyia*. There, the primitive plant formations, climate and soil type determine the distribution and occurrence of mosquitoes. In Brazil, large areas of equatorial, tropical and temperate climate and vegetation have allowed many species of Sabethini to thrive (Lane and Cerqueira 1942, Harbach et al. 2007).

However, since European colonization there have been changes in the original vegetation of the Americas caused by land use and other human activities. For instance, the destruction of forests in the state of Paraná, Brazil, started in 1820 with the cultivation of the yerba

mate. The original biota of the Atlantic Forest, including mangroves and salt marshes, and which covered 84% of the state's surface, today represents less than 8% of the area. The Atlantic Forest is currently reduced to disjointed spots, most of them constituting formations secondary stages in different successional stages (Maack 1981, Kronen 1990, Morellato and Haddad 2000).

Studies on the fauna of mosquitoes in regions of Paraná that have remaining forests have demonstrated the existence of populations of Sabethini (Bona and Navarro-Silva 2008, Tissot and Navarro-Silva 2008, Muller et al. 2008, 2012, Guedes and Navarro-Silva 2014). In this study, we report new records from protected and residual forests in the state.

Methods

The study area is within the state of Paraná, which is located in southern Brazil. Entomological surveys were conducted between 2004 and 2005 in the forested areas of 18 localities, distributed in 20 municipalities (2 points are in contiguous municipalities), represented by environmental preservation areas and private properties, with the presence of residual forests (Table 1; Fig. 1).

Females of Sabethini were collected inside the forest using the human attraction technique. The mosquitoes were captured using a tube containing Chloroform and by hand nets. Ground-level samples were collected over a transect with 18 focal points separated by 10 m. Each central point was positioned about 30 m from a tree in the forest canopy selected for collection. The collector

remained for 20 min at each focal point. Collections in the tree tops were made between 10 m and 15 m from the ground and considered the average height of the dominant trees at each site. To collect in the canopy, various types of platforms were accessed through rope ladders and pulleys.

For each species, we give the known distribution in the Americas and the new records, detailing the collection site: geographical coordinates and altitude above (mean) sea level (a.s.l); date of collection; researched forest stratum (CO = Canopy, Soil = SO); and time interval and the number of specimens collected. The information is supplemented with the species' bionomic data and the specimen number in the entomological collection (DZUP).

Specimens were identified with the help of dichotomous keys by Lane (1953) and Forattini (2002), and the literature describing species of Sabethini. Dr Maria Anice Mureb Sallum (Faculdade de Saúde Pública, Universidade de São Paulo) confirmed our identifications. Voucher materials were deposited in the Padre Jesus Santiago Moure Entomological Collection (Diptera), Departamento de Zoologia, Universidade Federal do Paraná (DZUP).

Knowledge of the distribution of Sabethini in the Americas was obtained from Navarro et al (2015), and

Table 1. Geographical coordinates of the field stations where insect collecting took place in the forested areas of Paraná, between April, 2004 to June 2006.

RS*	Municipality	Coordinates
Dense Ombrophilous Forest		
	Paranaguá	25°54'44.9"S, 048°56'31.2"W
	Matinhos	26°25'24.5"S, 048°57'28.7"W
	Guaraqueçaba	25°18'22.4"S, 048°43'15.1"W
Mixed Ombrophilous Forest		
	Piê	26°10'40.4"S, 049°42'26.9"W
	Prudentópolis	24°48'00.0"S, 051°14'00.0"W
	Mariópolis	26°16'08.0"S, 052°33'53.0"W
Fields (Campo Geral and Cerrado)		
	Jaguaraiáva	24°22'43.6"S, 049°39'38.0"W
Seasonal Semideciduous Forest		
	Carlópolis and Joaquim Távora	23°15'24.1"S, 050°57'55.9"W
	Tomazina	23°50'57.9"S, 049°57'36.1"W
	Três Barras do Paraná	25°26'22.0"S, 053°09'34.0"W
	Foz do Iguaçu	25°36'26.0"S, 054°26'50.0"W
	Terra Roxa	23°03'18.8"S, 054°08'03.7"W
	Cornélio Procópio and Santa Mariana	23°09'03.4"S, 050°34'17.8"W
	Assaí	23°22'01.9"S, 050°49'32.8"W
	Maringá	23°43'00.6"S, 052°33'11.8"W
	Inajá	22°39'25.8"S, 052°15'15.8"W
	Porto Rico	23°15'26.4"S, 053°28'10.7"W
	Cianorte	24°08'13.9"S, 053°00'52.9"W

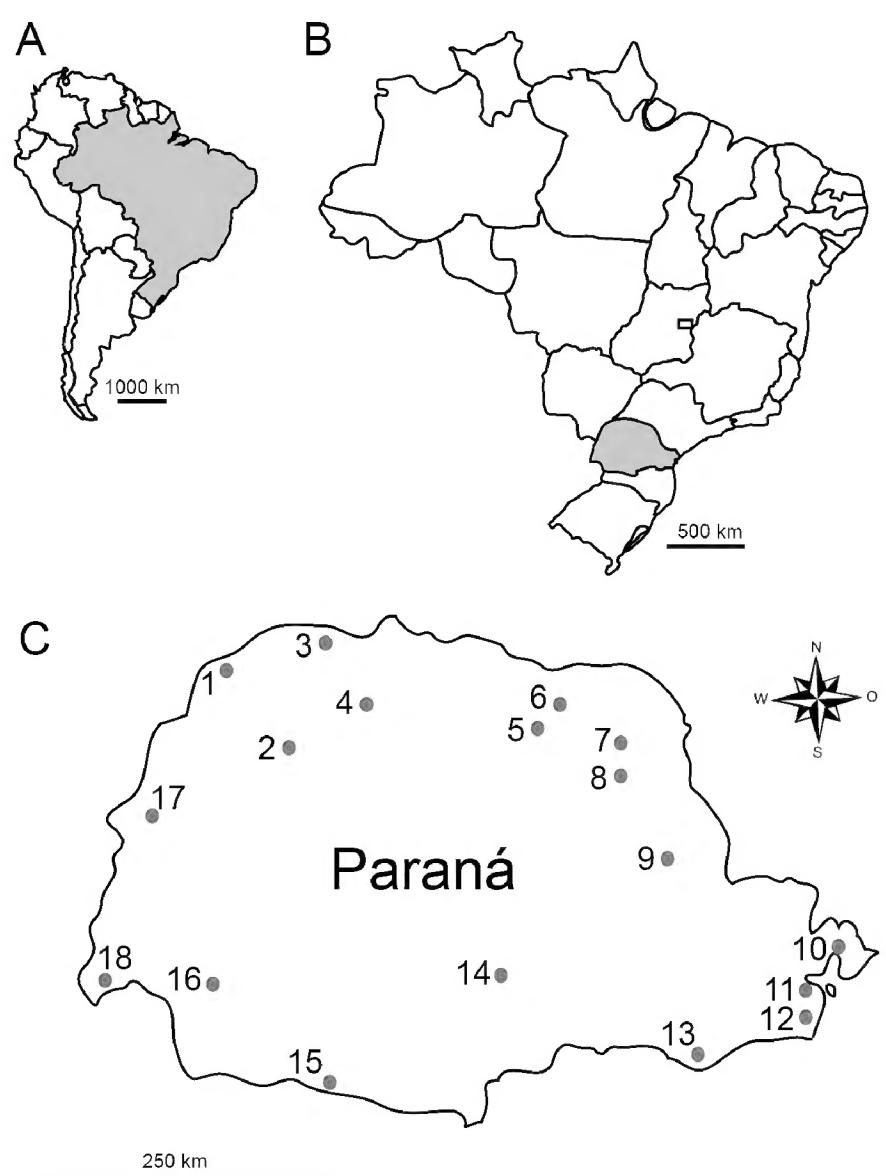


Figure 1. A. Location of Brazil in South America. B. Location of the state of Paraná in Brazil. C. Distribution of municipalities in the state of Paraná, with record of the first occurrence of mosquitoes. Legend: 1. Porto Rico, 2. Cianorte, 3. Inajá, 4. Maringá, 5. Assaí, 6. Cornélio Procópio and Santa Mariana, 7. Carlópolis and Joaquim Távora, 8. Tomazina, 9. Jaguaraiáva, 10. Guaraqueçaba, 11. Paranaguá, 12. Matinhos, 13. Piê, 14. Prudentópolis, 15. Mariópolis, 16. Três Barras do Paraná, 17. Terra Roxa, 18. Foz do Iguaçu.

the Walter Reed Biosystematics Unit (2017) online catalog. To check the originality of the species records in southern Brazil and Paraná, we consulted Lane and Cerqueira (1942), and the lists of entomological collections presented by Marchon-Silva et al. (1996), Hutchings et al. (2005), and Tissot and Navarro-Silva (2008). In addition, the lists compiled by Cardoso et al. (2005, 2010) for Rio Grande do Sul and Müller et al. (2008) for Paraná and Santa Catarina were also consulted. The distribution of mosquito species is presented based on the main natural characteristics of Paraná, according to the Maack (1981) and Wons (1985).

The review of articles published after the lists mentioned above include: for Rio Grande do Sul: Gomes et al. (2010); for Paraná: Anjos and Navarro-Silva (2008), Bona and Navarro-Silva (2008), Tissot and Navarro-Silva (2008), Marchi et al. (2010), Müller et al. (2012), Guedes and Navarro-Silva (2014) and Lopes et al. (2014); and for Santa Catarina: Gomes et al. (2009), Reis et al. (2010), Favretto et al. (2013), Müller et al. (2014), Santos et al. (2014) and Ferreira-de-Freitas et al. (2016).

The nomenclature and taxonomic classification of the Sabethini follows Motta et al. (2007) and Harbach (2018). The abbreviation of genera and subgenera follow Reinert (2009).

Results

The identification of Sabethini mosquitoes collected in forested environments of Paraná, based on the morphological characteristics of the female, resulted in 12 new records, including 7 species of *Wyeomyia* Theobald, 1901, and 5 species of *Sabates* Robineau-Desvoidy, 1827. Among them, 6 are new records for southern Brazil, and 6 are new records for Paraná.

First records for southern Brazil

Sabates (Sabethes) shannoni Cerqueira, 1961

Figures 2A, 3A–C

Distribution. Brazil.

New records. Brazil: Paraná: Cornélio Procópio, Parque Estadual Mata São Francisco ($23^{\circ}09'03''S$, $050^{\circ}34'17''W$, 553 m a.s.l.); coll. 09.VIII.2004, SO 12h40–13h00, 1♀ (voucher DZUP 180506).

Bionomic data. This species occurs in the Terceiro Planalto Paranaense and is found in preserved forest with original characteristics, which is in the small basin of the Paranapanema River. The region has an annual average air temperature of 21–22 °C and average rainfall of 1,600–1,800 mm annually.

Identification. *Sa. (Sab.) shannoni* differs from *Sa. (Sab.) tarsopus* Dyar & Knab, 1908, *Sa. (Sab.) ortizi* Vargas & Nájera, 1961 and *Sa. (Sab.) belisaroi* Neiva, 1908 by the extension of the white scale spots at the fore- and mid-tarsus. *Sa. (Sab.) shannoni* foretarsus is covered by white

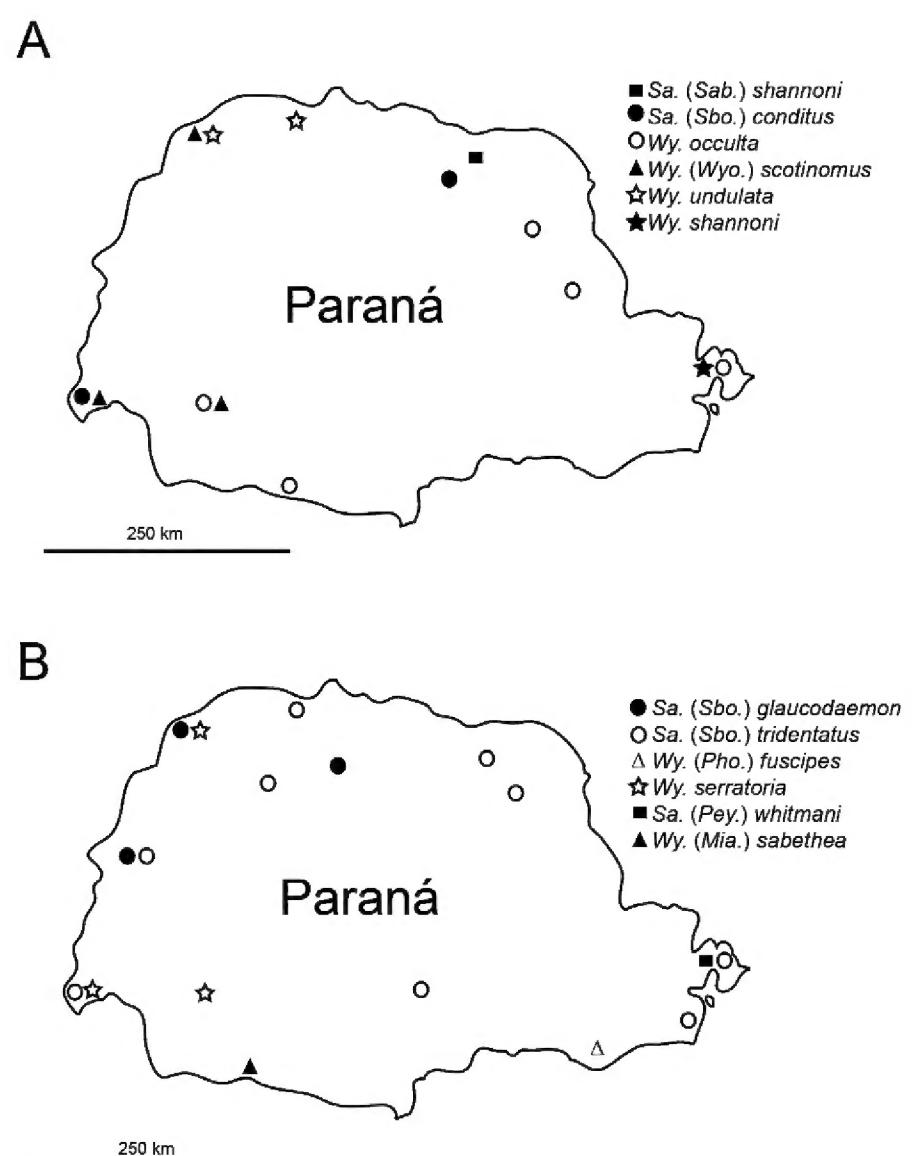


Figure 2. Location of the first records of the species in the state of Paraná, Brazil. **A.** First records for Southern Brazil. **B.** First records for the state of Paraná.

scales from the apex of the tarsomere (Ta) II to the base of Ta-IV (Fig. 3B) and the midtarsus has white scales on the base of Ta-II to the apex of Ta-IV (Fig. 3C).

Sabates (Sabethoides) conditus Moses, Howard & Harbach, 2000

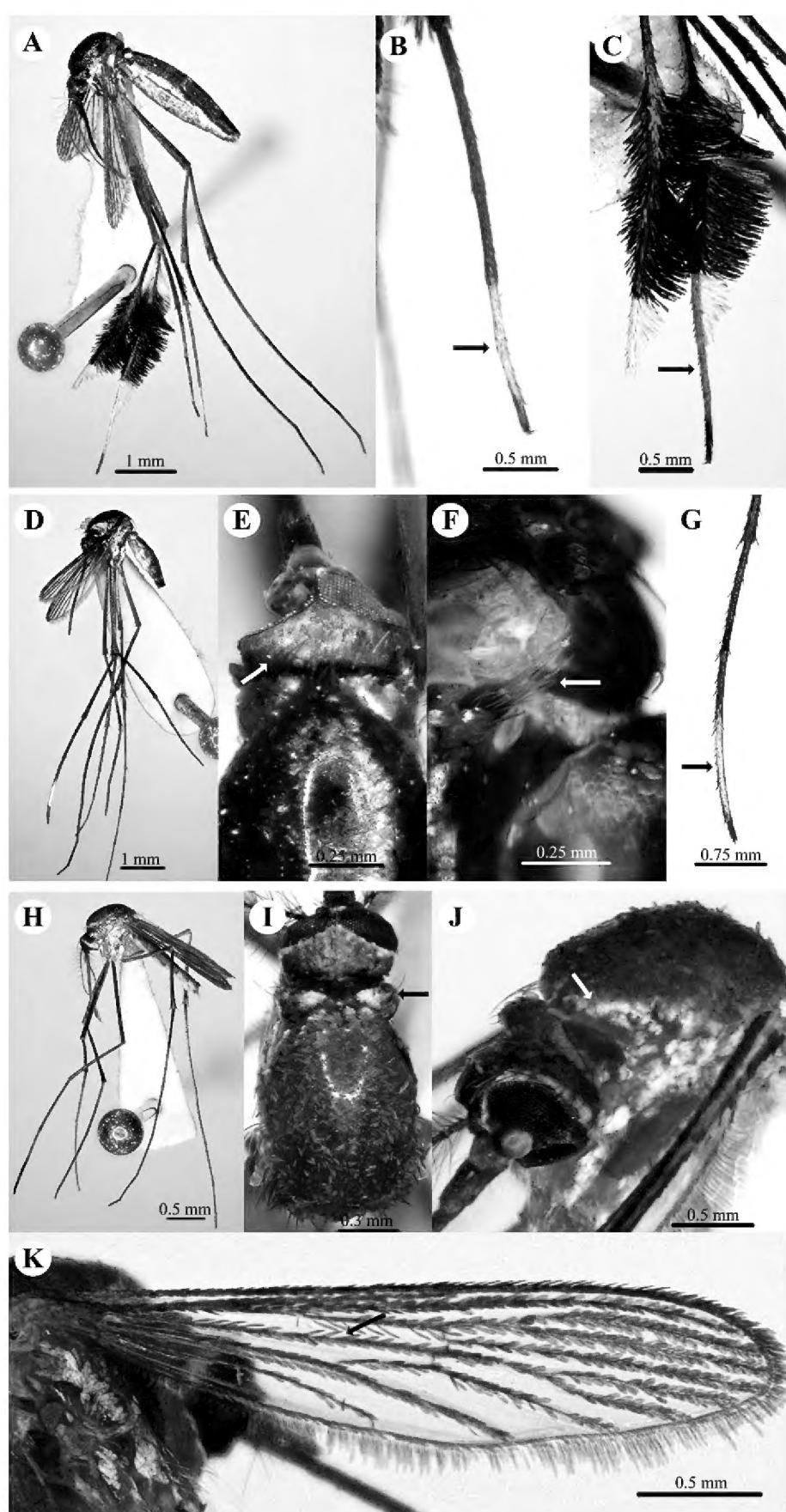
Figures 2A, 3D–G

Distribution. Brazil, Venezuela.

New records. Brazil: Paraná: Assaí, Cooperativa Algodoeira ($23^{\circ}43'00''S$, $050^{\circ}50'15''W$, 630 m a.s.l.); coll. 18.I.2005, SO 12h40–13h00, 1♀ (DZUP 180505). Brazil: Paraná: Foz do Iguaçu, Fazenda Keller ($25^{\circ}36'26''S$, $054^{\circ}28'48''W$, 228 m a.s.l.); coll. 15.III.2004, CO 17h00–18h00, 1♀ (DZUP249686).

Bionomic data. The species was collected in the Terceiro Planalto Paranaense in secondary riparian forest of the Tibagi River, near the mouth of the Iguaçu River. In the tropical zone area, the annual average air temperature ranges between 21 °C and 22 °C, while in the subtropical zone areas, the average annual air temperature varies between 19 °C and 21 °C. The average rainfall ranges from 1,600 mm to 1,800 mm annually.

Identification. *Sa. (Sbo.) conditus* is similar to *Sa. (Sbo.) chloropterus* (Humboldt, 1819), *Sa. (Sbo.) tridentatus* Cerqueira, 1961 and *Sa. (Sbo.) glaucodaemon* (Dyar & Shannon, 1925), but differs by the occiput with golden-green scales (Fig. 3E), short upper mesepimeral setae reaching the mesopostnotum (Fig. 3F) and the midtarsus



Figures 3. A–C. *Sabethes (Sabethes) shannoni*: (A) lateral view; (B) foretarsus with white scales on apex of tarsomere (Ta) II to base of Ta-IV; (C) midtarsus with white scales on the base of Ta-II to the apex of Ta-IV. D–G. *Sabethes (Sabethoides) conditus*: (D) lateral view; (E) occiput with golden-green scales; (F) short upper mesepimeral setae, reaching the mesopostnotum; (G) midtarsus covered with white scales on the anterior surface of Ta-II to Ta-IV. H–K. *Wyeomyia occulta*: (H) lateral view; (I) dorsal view, with pronotal lobes covered with dark scales with violet reflexes; (J) pronotum covered with white scales; (K) wing with the base of vein M covered by long and large scales.

is covered with white scales on the anterior surface of Ta-II to Ta-IV (Fig. 3G).

Wyeomyia (uncertain subgenus) *occulta* (Bonne-Wepster & Bonne, 1919)

Figures 2A, 3H–K

Distribution. Argentina, Bolivia, Brazil, Ecuador, French Guiana, Guyana, Suriname.

New records. Brazil: Paraná: Guarqueçaba, Tagaçaba ($25^{\circ}13'19''$ S, $048^{\circ}27'27''$ W, 16 m a.s.l.); col. 08.VI.2004,

SO 09h40–12h20, 2♀ (DZUP 343604, DZUP 417174); c. 15.X.2004, SO 09h00–14h40, 8♀ (DZUP 417170, 417171, 417172, 417173, 417174, 417181, 417182, 417183, 417189). Brazil: Paraná: Três Barras do Paraná, Parque Estadual do Rio Guarani ($25^{\circ}26'22''$ S, $053^{\circ}09'34''$ W, 491 m a.s.l.); col. 23.XI.2004, SO 10h00–11h40, 2♀ (DZUP 343599, DZUP 343649). Brazil: Paraná: Jaguariaíva, Patrimônio Bom Sucesso ($24^{\circ}22'44''$ S, $049^{\circ}39'38''$ W, 850 m a.s.l.); col. 10.III.2005, SO 12h40–13h00, 1♀ (DZUP 343543). Brazil: Paraná: Mariópolis, Linha São Pedro ($26^{\circ}19'50''$ S, $052^{\circ}33'53''$ W, 853 m a.s.l.); col. 03.III.2005, SO 13h20–13h40, 1♀; col. 12.V.2005, SO 10h40–11h40, 1♀ (DZUP 343606).

Bionomic data. This species is widely distributed in Paraná, occurring in the Serra do Mar and Segundo and Terceiro Planalto Paranaense and covering 4 different landscape features: Dense Ombrophilous Forest (coastal), Campos Gerais, Mixed Ombrophilous Forest Temperate zone and Seasonal Semideciduous Forest. At the Paraná coast, this species was collected in the hydrographic basin of the Laranjeiras Bay, while in the rest of the state it was found in the Itararé, Cinzas, Laranjinha and Iguaçu river valleys, which are part of the basin of the Paraná River. On the coast, the air temperature ranges between 19 °C and 20 °C and the amount of rainfall ranges between 2,000 mm and 3,000 mm annually. In the areas of the subtropical zone the average annual air temperature varies between 19 °C and 21 °C, while in the forest it ranges between 17 °C and 18 °C. In these regions, the average rainfall ranges from 1,100 mm to 1,800 mm annually. In the temperate zone, the average air temperatures are lower, between 15 °C and 16 °C, with rainfall of 1,800 mm to 2,000 mm annually.

Identification. *Wy. occulta* is characterized by the pronotal lobes covered with dark scales with violet reflexes (Fig. 3I) and the wing with the base of vein M covered by long and large scales (Fig. 3K). It differs from *Wy. (Hys.) autocratica* Dyar & Knab, 1906 by having the pronotum covered with white scales (Fig. 3J).

Wyeomyia (Wyeomyia) scotinomus (Dyar & Knab, 1907)

Figures 2A, 4A–C

Distribution. Argentina, Brazil, Colombia, Costa Rica, Ecuador, Guyana, Nicaragua, Panama, Paraguay, Trinidad and Tobago.

New records. Brazil: Paraná: Foz do Iguaçu, Fazenda Keller ($25^{\circ}36'26''$ S, $054^{\circ}28'49''$ W, 228 m a.s.l.); col. 21.II.2005, SO 15h00–16h00, 2♀ (DZUP 343530, DZUP 343562). Brazil: Paraná: Porto Rico, Ilha Mutum, Parque Nacional de Ilha Grande ($22^{\circ}45'35''$ S, $053^{\circ}16'08''$ W, 241 m a.s.l.); col. 22.III.2004, CO 10h00–11h00, 1♀ (DZUP 343564); col. 12.IV.2004, SO 10h20–10h40, 1♀ (DZUP 343567); col. 13.IV.2004, CO 13h00–14h00, 1♀ (DZUP 343565); col. 17.V.2004, SO 11h00–12h00, 1♀ (DZUP 343568). Brazil: Paraná: Três Barras do Paraná, Parque

Estadual do Rio Guarani ($25^{\circ}26'22''$ S, $053^{\circ}09'34''$ W, 491 m a.s.l.); col. 10.V.2005, SO 14h40–15h00, 1♀ (DZUP 343602).

Bionomic data. This species was detected in the Segundo and Terceiro Planalto Paranaense, where it occurred in Seasonal Semideciduous Forest of humid tropical and subtropical areas. Populations of this mosquito were observed in secondary forests on islands of the Paraná River, as well as in western and southwestern forests of the state that retain primitive characteristics, including the presence of bamboo and conifers. In the tropical zone areas, the annual average air temperature ranges between 21°C and 22°C , while in the subtropical zone areas the average annual air temperature varies between 19°C and 21°C . In these regions, the average rainfall ranges from 1,100 mm to 1,800 mm annually.

Identification. *Wy. (Wye.) scotinomus* has the wings with the base of vein M covered by long and large scales (Fig. 4B) and differs from *Wy. (Wye.) nigritubus* Galindo, Carpenter & Trapido, 1951 by having the midtarsus covered with white scales from tarsomere (Ta) II to the base of Ta-V (Fig. 4C).

Wyeomyia (uncertain subgenus) shannoni Lane & Cerqueira, 1942

Figure 2A

Distribution. Brazil, Ecuador, Nicaragua.

New records. Brazil: Paraná: Guaraqueçaba, Tagaçaba ($25^{\circ}13'19''$ S, $048^{\circ}27'27''$ W, 16 m a.s.l.); col. 15.X.2004, SO 11h20–11h40, 1♀ (DZUP 180622).

Bionomic data. This species occurred in typical Atlantic Forest along the coast of Paraná, within the hydrographic basin of Laranjeiras Bay, which flows directly into the Atlantic Ocean. In this region, the average annual air temperature varies between 19°C and 20°C , and the average rainfall is between 2,000 mm to 3,000 mm.

Identification. *Wy. shannoni* differs from *Wy. knabi* Lane & Cerqueira, 1942 by presenting the foretarsus bearing white scales at one side of tarsomere V (Ta-V) and pronotal lobes covered with scales with intense blue violet reflections.

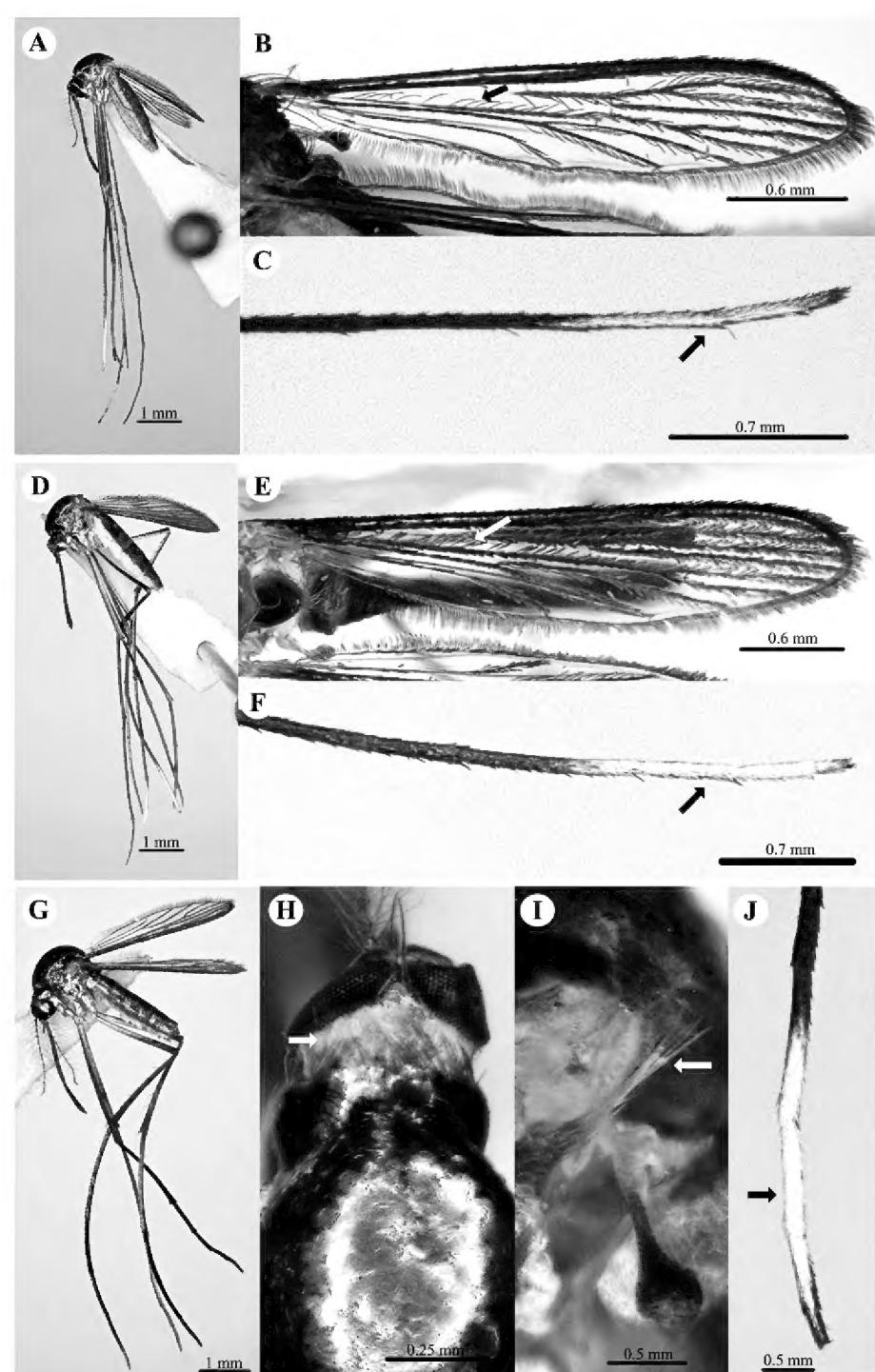
Wyeomyia (uncertain subgenus) undulata Del Ponte & Cerqueira, 1938

Figures 2A, 4D–F

Distribution. Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Nicaragua, Panama, Paraguay.

New records. Brazil: Paraná: Inajá, Fazenda Paranapanema ($22^{\circ}38'10''$ S, $052^{\circ}15'16''$ W, 263m a.s.l.); col. 27.IV.2004, SO 10h20–15h00, 10♀ (DZUP 343665, 343666, 416737, 416937, 416938, 416951, 416888, 416889, 416890, 417002); col. 07.VII.2004, SO 12h20–12h40, 1♀ (DZUP 344453).

Bionomic data. This species was collected in the Ter-



Figures 4. A–C. *Wyeomyia (Wyeomyia) scotinomus*. (A) lateral view. (B) wing with the base of vein M covered by long and large scales. (C) midtarsus with white scales from tarsomere (Ta) II to the base of Ta-V. **D–F.** *Wyeomyia undulata*. (D) lateral view. (E) wing with the base of vein M covered by long and large scales. (F) midtarsus with white scales from Ta-II to the middle of Ta-V. **G–J.** *Sabethes (Sabethoides) glaucodaemon*. (G) lateral view. (H) dorsal view, occiput covered with scales with purple reflexes. (I) long upper mesepimeral setae, reaching the mesopostnotum. (J) midtarsus with white scales from apex of Ta-II to the base of Ta-V.

ceiro Planalto Paranaense in secondary tropical forest areas along the banks of the Paranapanema River and on islands of the Paraná River. In this region, the average annual air temperature is between 21°C and 22°C and average rainfall varies between 1,100 mm and 1,600 mm annually.

Identification. *Wy. undulata* is very similar to *Wy. roucoulana* (Bonne-Wepster & Bonne, 1920) and *Wy. chalcocephala* Dyar & Kanb, 1906, but differs by presenting wings with the base of vein M covered by long and large scales (Fig. 4E) and the midtarsus with white scales from Ta-II to the middle of Ta-V (Fig. 4F).

First records for the state of Paraná

Sabethes (Peytonulus) whitmani Lane & Cerqueira, 1942

Figure 2B

Distribution. Brazil.

New records. Brazil: Paraná: Paranaguá, Colônia Santa Rita ($25^{\circ}32'49''$ S, $048^{\circ}33'50''$ W, 14 m a.s.l.); col. 21.IX. 2004, SO 12h40–13h00, 1♀ (DZUP 180623).

Bionomic data. This species is found in forest fragments of the coast of Paraná, belonging to the hydrographic basin of Paranaguá Bay. The average annual air temperature ranges from 21°C to 22°C , and the average rainfall varies from 1,800 mm to 2,000 mm.

Identification. *Sa. (Pey.) whitmani* differs from *Sa. (Pey.) soperi* Lane & Cerqueira, 1942 by having the hindtarsus Ta-5 entirely covered by dark scales.

***Sabethes (Sabethoides) glaucodaemon* (Dyar & Shannon, 1925)**

Figures 2B, 4G–J

Distribution. Bolivia, Brazil, Guyana, Suriname.

New records. Brazil: Paraná: Porto Rico, Ilha Mutum, Parque Nacional de Ilha Grande ($22^{\circ}45'35''$ S, $053^{\circ}16'08''$ W, 241 m a.s.l.); col. 22.III.2004, CO 11h00–12h00, 1♀ (DZUP 343668). Brazil: Paraná: Terra Roxa, Fazenda Curupay ($24^{\circ}01'60''$ S, $054^{\circ}05'57''$ W, 244 m a.s.l.), col. 27.X.2004, CO 07h00–00h00, 7♀ (DZUP 343652, 343656, 343663, 3343664, 343669, 343675, 344688) and col. 25.I.2005, CO 18h00–19h00, 2♀ (DZUP 180507, DZUP 343657). Brazil: Paraná: Maringá, Horto Florestal – Parque do Ingá ($23^{\circ}25'37''$ S, $051^{\circ}55'42''$ W, 543 m a.s.l.); col. 20.XII.2005, SO 14h20–14h40, 1♀ (DZUP 180508) and CO 14h00–15h00, 1♀ (DZUP 417088).

Bionomic data. This species occurred in the Terceiro Planalto Paranaense in tropical rain forests of the Ivaí river valley, at the mouth of the Piquiri River, and in typical marshland vegetation and flood plains of the Paraná River. In these regions, the average annual air temperature ranges from 20°C to 22°C , and average rainfall varies from 1,100 mm to 1,800 mm.

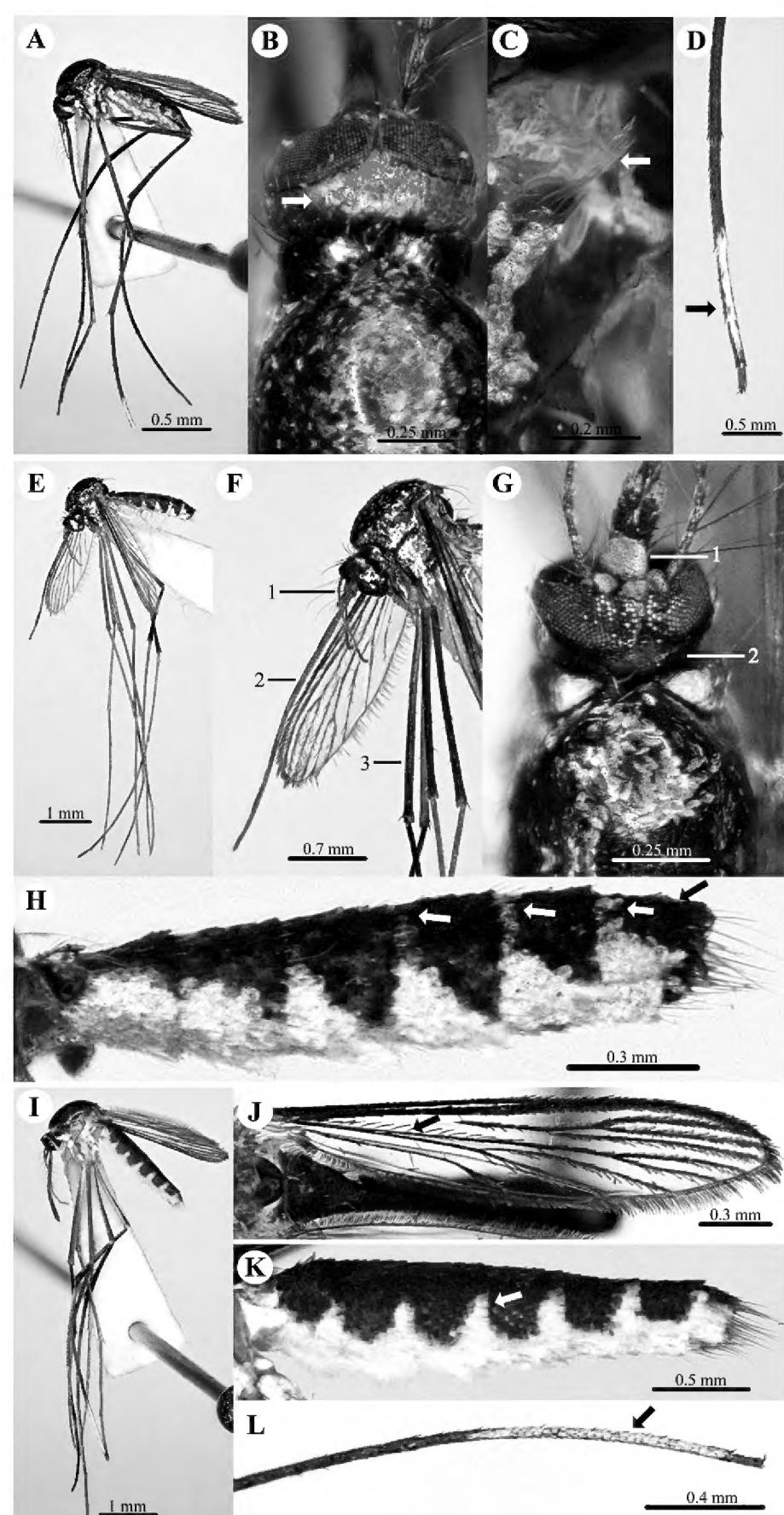
Identification. *Sa. (Sbo.) glaucodaemon* is very similar to *Sa. (Sbo.) tridentatus* and *Sa. (Sbo.) chloropterus* but differs by having the occiput covered with scales with purple reflexes (Fig. 4H), long upper mesepimeral setae, reaching the mesopostnotum (Fig. 4I), and midtarsus with white scales from apex of Ta-II to the base of Ta-V (Fig. 4J).

***Sabethes (Sabethoides) tridentatus* Cerqueira, 1961**

Figures 2B, 5A–D

Distribution. Brazil.

New records. Brazil: Paraná: Foz do Iguaçu, Fazenda Keller ($25^{\circ}36'26''$ S, $054^{\circ}28'49''$ W, 228 m a.s.l.); col. 15.III.2004, CO 13h00–16h00, 4♀ (DZUP 180519, 180520, 180523, 180524), CO 08h00–11h00, 2♀ (DZUP 180521, DZUP 180522) and SO 15h00–16h00, 1♀ (DZUP 180511); col. 13.VII.2004, SO 09h40–11h20, 1♀ (DZUP 180518). Brazil: Paraná: Cornélio Procópio, Parque Estadual Mata São



Figures 5. A– D. *Sabethes (Sabethoides) tridentatus*. (A) lateral view. (B) dorsal view, occiput covered with scales with bluish green reflexes. (C) long upper mesepimeral setae, reaching the mesopostnotum. (D) midtarsus with white scales from apex of tarsomere (Ta) II to the base of Ta-V. **E– H.** *Wyeomyia (Phoniomyia) fuscipes*. (E) lateral view. (F) antenna (1) shorter than proboscis (2) and proboscis longer than anterior femur (3). (G) clypeus (1) without scales; and occiput (2) pronotal lobes covered with scales with purple-green reflexes. (H) abdomen lateral view, with presence of apical white scales from tergite V to VII (white arrows) and absence on tergite VIII (white arrow). **I– L.** *Wyeomyia serratoria*. (I) lateral view. (J) wing with the base of vein M covered by long and large scales. (K) abdomen lateral view, with presence of basal white scales from tergite II to VII (white arrows) (L) midtarsus with white scales from apex of tarsomere (Ta) II to the base of Ta-V.

Francisco ($23^{\circ}09'03''$ S, $050^{\circ}34'18''$ W, 553 m a.s.l.); col. 21.II.2005, SO 14h40–15h00, 1♀ (DZUP 180509) and CO 14h00–15h00, 1♀ (DZUP 180510). Brazil: Paraná: Terra Roxa, Fazenda Curupay ($24^{\circ}01'60''$ S, $054^{\circ}05'57''$ W, 244 m a.s.l.); col. 22.VI.2004, CO 11h00–12h00, 1♀ (DZUP 180512); col. 13.XII.2004, SO 15h20–18h00, 4♀ (DZUP 343650, 343651, 343653, 343655), col. 16.XII.2004,

SO 10h40–11h00, 1♀ (DZUP 343662). Brazil: Paraná: Inajá, Fazenda Paranapanema ($22^{\circ}38'10''$ S, $052^{\circ}15'16''$ W, 263 m a.s.l.); col. 07.VII.2004, CO 11h40–15h00, 1♀ (DZUP416862); col. 01.III.2005, SO 10h40–15h00, 2♀ (DZUP416868, DZUP416984). Brazil: Paraná: Matinhos, Cabaraquara ($25^{\circ}50'07''$ S, $048^{\circ}34'21''$ W, 24 m a.s.l.); col. 19.X.2004, SO 11h00–12h40, 1♀ (DZUP 180517) and SO 11h40–12h00, 1♀ (DZUP 180514). Brazil: Paraná: Guaraqueçaba, Tagaçaba ($25^{\circ}13'19''$ S, $048^{\circ}27'27''$ W, 16 m a.s.l.); col. 15.X.2004, SO 09h00–11h20, 1♀ (DZUP417169) and SO 10h00–10h20, 1♀ (DZUP 180515). Brazil: Paraná: Prudentópolis, Fazenda Álamo ($24^{\circ}48'00''$ S, $051^{\circ}14'00''$ W, 514 m a.s.l.); col. 21.IV.2005, CO 12h00–15h00, 2♀ (DZUP 180525, DZUP417094). Brazil: Paraná: Cianorte, Companhia Melhoramento Norte do Paraná ($23^{\circ}39'26''$ S, $053^{\circ}37'01''$ W, 511 m a.s.l.); col. 11.II.2005, SO 11h00–11h20, 1♀ (DZUP 180513). Brazil: Paraná: Carlópolis and Joaquim Távora, Fazenda Capela ($23^{\circ}30'36''$ S, $049^{\circ}48'59''$ W, 693 m a.s.l.); col. 23.II.2006, SO 10h00–10h20, 1♀ (DZUP 180516).

Bionomic data. This species is widely distributed in Paraná, where it occurs along the coast and in Serra do Mar, Segundo and Terceiro Planalto Paranaense. Within this range, this species was observed in 4 different landscapes: Dense Ombrophilous Tropical and Subtropical forests, Mixed Temperate Ombrophilous Forest and Semideciduous Seasonal Forest. On the coast this species was collected in the hydrographic basin of Laranjeiras Bay and in areas where streams flow directly into the Atlantic Ocean. In the interior, however, it was found in the valleys of the Itararé, Cinzas, Laranjinha, Ivaí, Piquiri Iguaçu and Paraná rivers, which are part of the Paraná river basin. In the coastal region, the air temperature ranges between 19°C and 22°C and rainfall ranges between 1,800 mm and 3,000 mm annually. In the subtropical zone, the average annual air temperature varies between 19°C and 22°C , while the average rainfall ranges from 1,100 mm to 1,800 mm. In the temperate zone the average temperature of the air is lower, between 16°C and 17°C , with rainfall between 1,600 mm and 1,800 mm.

Identification. *Sa. (Sab.) tridentatus* differs from *Sa. (Sbo.) glaucodaemon* and *Sa. (Sbo.) chloropterus* by presenting an occiput covered with scales with bluish green reflexes (Fig. 5B), long upper mesepimeral setae, reaching the mesopostnotum (Fig. 5C) and a midtarsus with white scales from apex of tarsomere (Ta) II to the base of Ta-V (Fig 5D).

Wyeomyia (Miamiya) sabethaea Lane & Cerqueira, 1942

Figure 2B

Distribution. Argentina and Brazil.

New records. Brazil: Paraná: Mariópolis, Linha São Pedro ($26^{\circ}19'50''$ S, $052^{\circ}33'53''$ W, 853 m a.s.l.); col. 12.VIII.2004, SO 14h00–14h20, 1♀.

Bionomic data. This species occurs in the Terceiro Planalto Paranaense in gallery forests found along the Iguaçu river basin where the average annual air temperature ranges from 15°C to 16°C , and the average rainfall is 1,800 mm to 2,000 mm per year.

Identification. *Wy. (Mia.) sabethaea* is differentiated from other species by having wings with the base of vein M covered by narrow scales, the tergite bearing small basal white scales, and maxillary palpi with 3 times the size of the proboscis.

Wyeomyia (Phoniomyia) fuscipes (Edwards, 1922)

Figures 2B, 5E–H

Distribution. Brazil and Paraguay.

New records. Brazil: Paraná: Piên, Boa Vista ($26^{\circ}06'45''$ S, $049^{\circ}23'14''$ W, 870 m a.s.l.); col. 05.V.2005, SO 12h20–12h40, 1♀ (DZUP 180497).

Bionomic data. This species was found in the Primeiro Planalto Paranaense, where it occurred in forested portions of Araucaria in the Iguaçu river basin. In this area the average annual air temperature ranges from 14°C to 15°C , and average rainfall ranges from 1,600 mm to 1,800 mm.

Identification. *Wy. (Pho.) fuscipes* is characterized by antenna shorter than proboscis and proboscis longer than anterior femur (Fig. 5F). This species also differs from other species by having the clypeus without scales, the occiput pronotal lobes covered with scales with purple-green reflexes (Fig. 5G), and the abdomen with apical white scales from tergite V to VII and absence on tergite VIII (Fig. 5H).

Wyeomyia (uncertain subgenus) serratoria (Dyar & Nuñez Tovar, 1927)

Figures 2B, 5I–L

Distribution. Argentina, Brazil, Colombia e Venezuela.

New records. Brazil: Paraná: Foz do Iguaçu, Fazenda Keller ($25^{\circ}36'26''$ S, $054^{\circ}28'48''$ W, 228 m a.s.l.); col. 15.IX.2004, SO 10h00–11h00, 1♀ (DZUP 180499). Brazil: Paraná: Porto Rico, Ilha Mutum, Parque Nacional de Ilha Grande ($22^{\circ}45'34''$ S, $053^{\circ}16'08''$ W, 241 m a.s.l.); col. 23.III.2004, SO 14h00–15h00, 1♀ (DZUP 180500). Brazil: Paraná: Três Barras do Paraná, Parque Estadual do Rio Guarani ($25^{\circ}26'22''$ S, $053^{\circ}09'34''$ W, 491 m a.s.l.); col. 23.XI.2004, SO 11h20–13h20, 2♀; CO 10h00–11h00, 1♀ (DZUP 343659); col. 01.III.2005, SO 12h00–15h00, 4♀ (DZUP 180502, 343667, 343672, 343673); col. 10.V.2005, SO 10h40–11h00, 2♀ (DZUP 343661, DZUP 343670).

Bionomic data. This species was found coexisting with *Wy. (Wyo.) scotinomus* in areas of seasonal semideciduous forest of the tropical and humid subtropical zones of the Segundo and Terceiro Planalto Paranaense. It occurred on the islands of the Paraná River and along the Iguaçu River in portions of remnant and secondary forests. In the

areas at the tropical zone the annual average air temperature ranges between 21 °C and 22 °C, while in the areas of subtropical zone the average annual air temperature varies between 19 °C and 21 °C. In these regions the average rainfall ranges from 1,100 mm to 1,800 mm.

Identification. *Wy. serratoria* is characterized by wings with the base of vein M covered by long and large scales (Fig. 5J), abdomen with basal white scales from tergite II to VII (Fig. 5K) and midtarsus with white scales from apex of tarsomere (Ta) II to the base of Ta-V (Fig. 5L).

Discussion

New records of Sabethini have been found for southern Brazil and the state of Paraná. With 2 exceptions noted below, the occurrence of most species of the tribe is best known for the Amazon region. *Wy. shannoni* and *Wy. undulata* had been previously recorded in state of Rio de Janeiro (Lane and Cerqueira 1957, Guimarães and Arlé 1984). Consequently, the records of the other species in the Atlantic Forest biome and the southernmost records of South America are new. Among the reported species, *Wy. (Wyo.) scotinomus* was previously only known from Central America (Costa Rica, Panama), the Caribbean island of Trinidad, and South America (Brazil, Colombia and Ecuador) (WRBU 2017, Navarro et al. 2015).

The other species of Sabethini are distributed in various states of the Amazon, for example *Sa. (Sab.) shannoni*, described from specimens collected in the Amazon, and *Sa. (Sbo.) conditus* from Rondônia (Cerqueira 1961, Moses et al. 2000). Similarly, *Wy. shannoni* and *Wy. undulata* were also described from specimens collected in Acre and Mato Grosso, respectively, and *Wy. occulta* has been reported as occurring in the state of Pará (Lane and Cerqueira 1957, Del Ponte and Cerqueira 1938).

Based on current observations, *Wy. (Wyo.) scotinomus* and *Wy. occulta* are now known to occur at the Iguaçu river valley, which is their southernmost record (latitude 25° and 26°, respectively). Additionally, *Sa. (Sab.) shannoni* and *Wy. undulata* were collected in the Paranapanema river valley (latitudes 23° and 22°, respectively), and *Sa. (Sbo.) conditus* in the Tibagi river valley (latitude 23°) were collected in northern Paraná. The record of *Wy. shannoni* on the coast of Paraná in Brazil expands its geographical distribution further south of previous records from areas of dense forest in the coastal states of Rio de Janeiro and São Paulo (Guimarães et al. 1989, 2000).

The first records of Sabethini for the state of Paraná had been previously found in southern Brazil. *Sabethes (Pey.) whitmani*, *Wy. (Pho.) fuscipes* and *Wy. (Mia.) sabethea* (Paterno & Marcondes 2004, Reis et al. 2010, Santos et al. 2014) had been previously found in the state of Santa Catarina; and *Sa. (Pey.) whitmani* (= morphotype *whitmani/identicus*), *Sa. (Sbo.) tridentatus*, *Wy. serratoria* and *Sa. (Sbo.) glaucodaemon* had been previously found in Rio Grande do Sul (Cardoso et al. 2005, Gomes et al. 2010).

Although researchers are still not sure whether Sabethini mosquitoes can transmit infectious agents to humans, their epidemiological importance is notorious, as they have been found naturally infected with arboviruses (Shope et al. 1961, Hervé et al. 1986). Their potential role in the natural cycle of arboviruses instigates us to try to understand how the transmission of these virus occur in the forest environment and whether it can affect humans. The answer to these questions is dependent on new studies on the behavior these mosquitoes in their natural environment, including isolated relict species in areas of remnant forests.

Acknowledgements

We thank Dr Natal Jataí de Camargo and his team from Secretaria de Estado da Saúde do Paraná for making this study possible, Prof. Dr Maria Anice Mureb Sallum for confirming our identifications of the specimens, and Kirsten Smith for the revision of the English version of the manuscript.

Authors' Contributions

AMS developed the research project that resulted in the article. AMS identified the specimens. DRS, ECC, ACF and CP participated in the collection of specimens. AMS and BWF developed the distribution map. BWF photographed and edited the images. AMS wrote the text and AMS, DRS, ECC, ACF, CP, BWF and MANS read, made suggestions and accepted the last version of the manuscript.

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